

ARP

The Process and the Protocol



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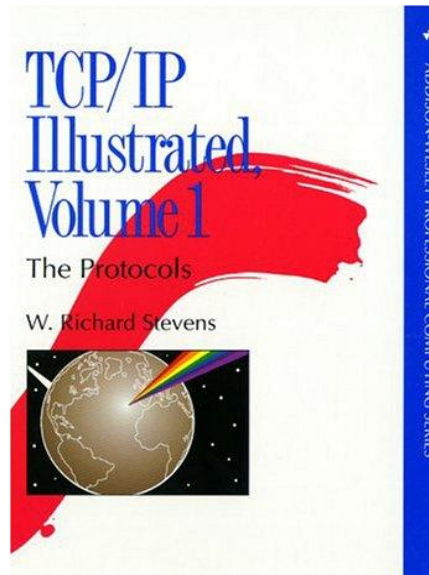
CIS 81 and CST 311

Rick Graziani

Fall 2006

Note to reader

- The information explained in this section is a simplification and extrapolation of the actual ARP determination process.
- Although conceptually accurate, the actual process is slightly different and more complex.
- However, for the purposes of this curriculum, the explanation contained in this section provide a good basis of understanding.
- For further reading, I suggest TCP/IP Illustrated Vol. 1 by W. Richard Stevens.



TCP/IP and ARP

The TCP/IP Suite of Protocols	
Application	File Transfer: FTP, TFTP, NFS, HTTP Email: SMTP Remote Login: Telnet, rlogin Network Management: SNMP, BootP Name Management: DNS, DHCP
Transport	TCP, UDP
Internet/Network	IP, ICMP, IGMP, ARP, RARP
Network Interface (Link Layer)	Not Specified: Ethernet, 802.3, Token Ring, 802.5, FDDI, ATM,

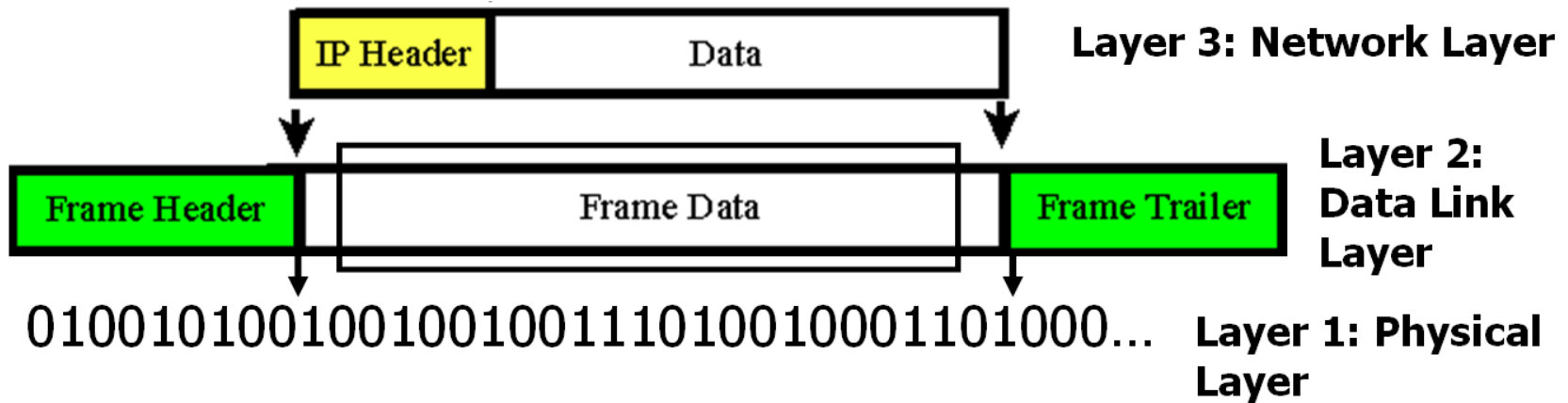
ARP is a layer 3 protocol, one of many protocols within the TCP/IP suite of protocols.

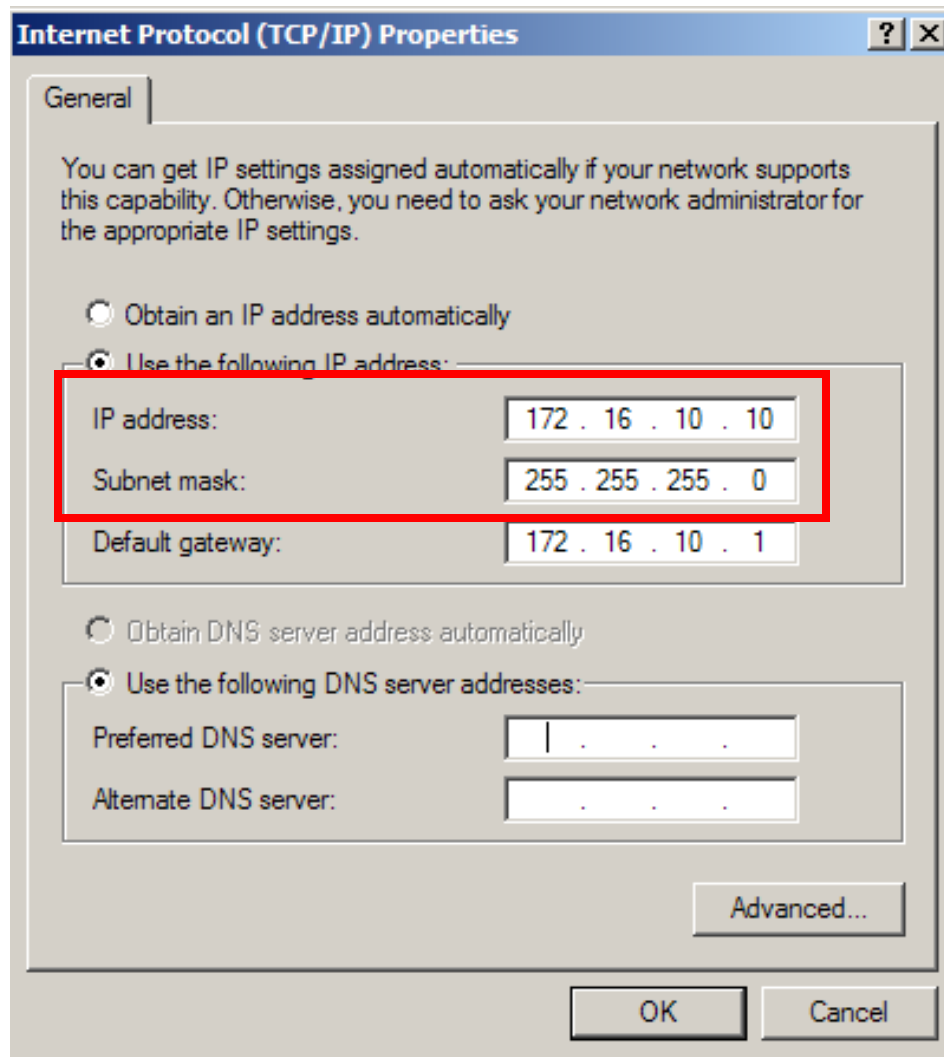
Why do devices have a MAC Address and an IP Address?

- Devices, (hosts, routers, servers, etc.) use IP addresses to reach other devices within their own network/subnet or across different networks/subnets.
- Layer 3 addresses such as IP addresses, which include an **original source address** of the sending device and the **final destination address** of the intended recipient.
- Again, these IP addresses consist of the **original** source address and **final** destination address.
- Once the packet is sent, these addresses **do not change**.
- Data Link addresses, such as Ethernet MAC addresses are used to get the IP packet from one hop to the next, within the same network.
- If the sender and the receiver are on different networks (or subnets) the data link address in the data link frame will be modified to reflect the new data link address source and data link address destination.
- This will become clearer in a moment.
- Again, the IP addresses do not change.
- You may wish to review the section on Encapsulation and Routers for more clarification.

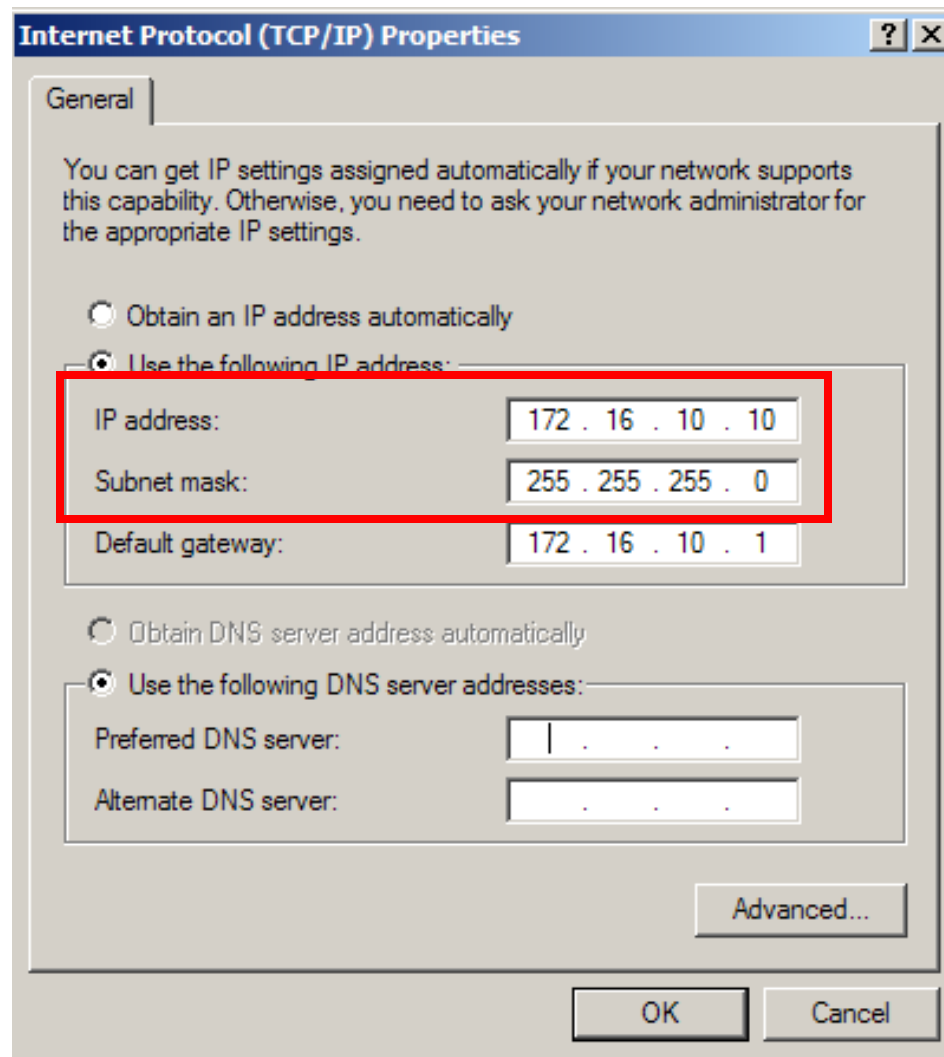
Why do devices have a MAC Address and an IP Address?

- The simple answer is deliver the IP packet inside an Ethernet frame to the next hop along the way.
- The next hop may very well be the final destination.
- To better explain this, lets use a couple of examples.





What information does the IP Address and Subnet provide for this host?



**Network
172.16.10.0**

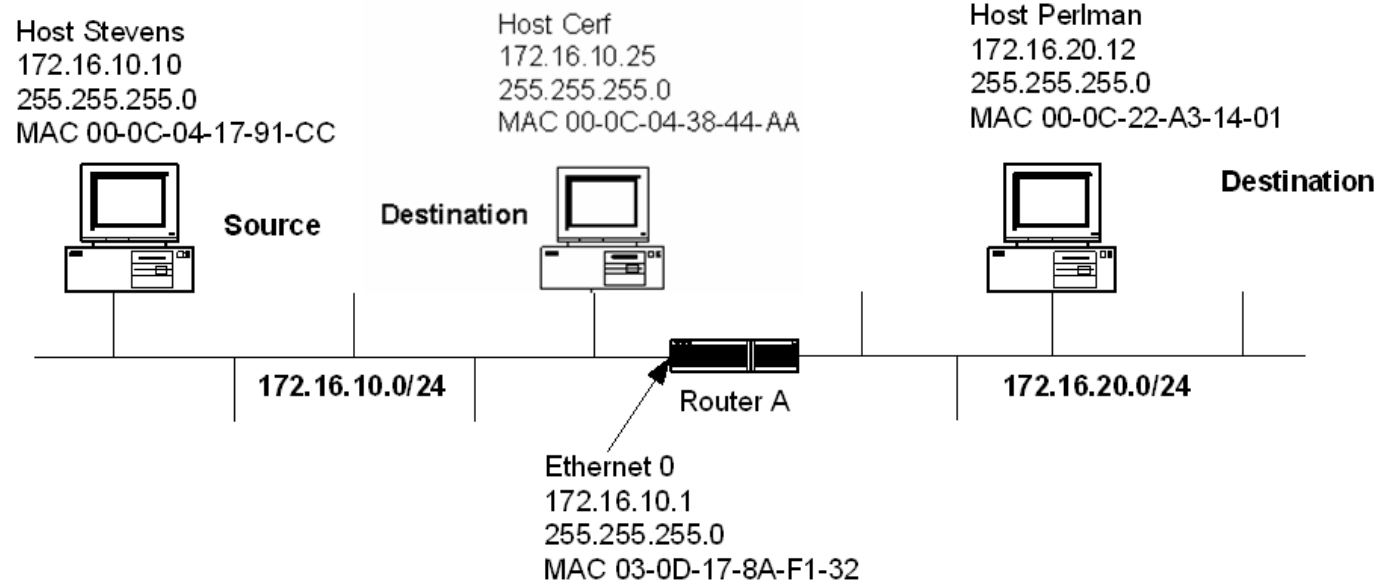
By doing the AND operation, it tells the host what network/subnet it belongs to.

Host IP Address and Subnet Mask

- What do all devices in the same LAN have in common?
 - Host IP address on the same network.
 - Same Subnet Mask.
- The AND operation on the host IP address and subnet mask tells the host what network it belongs to.



Destination MAC Address

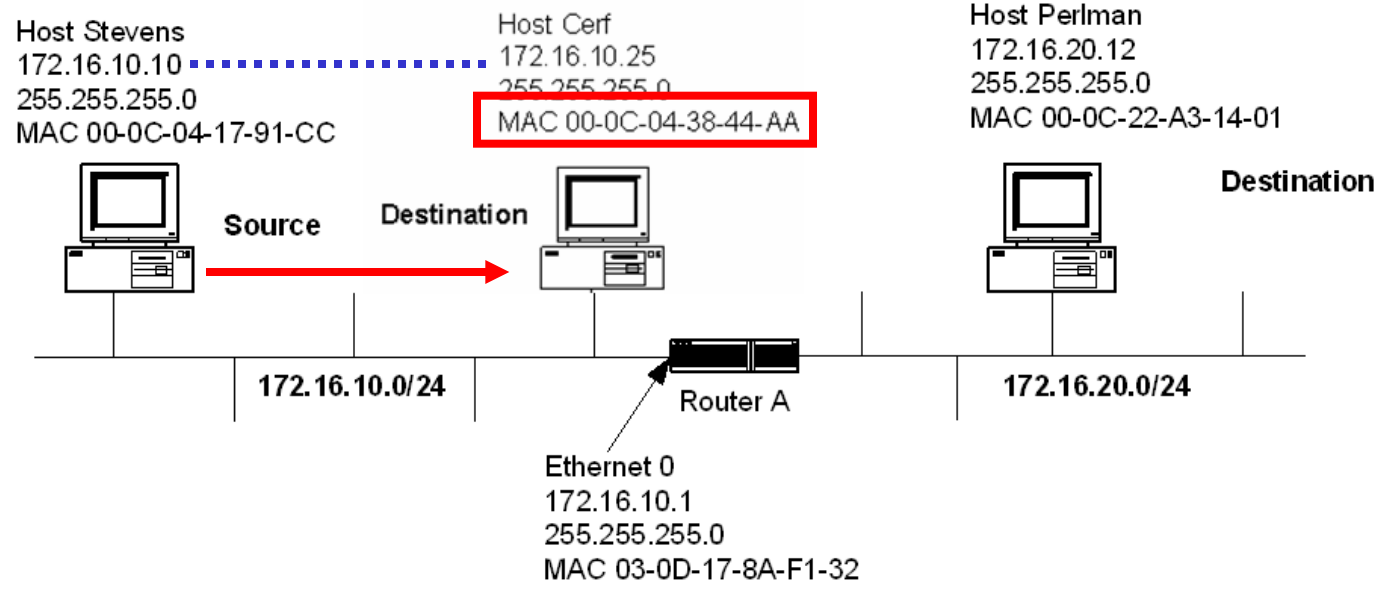


Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
?	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

- What does the **Ethernet Destination MAC Address** do?
 - Allows the transmission of the data (e.g. IP packet) to a device on the same LAN (also has an Ethernet NIC).
- What devices are on the same LAN?
 - Hosts, printers, etc. with that belong to the same IP network.
 - Default gateway, Router, which also has an IP address on the same network.

Destination MAC

Address



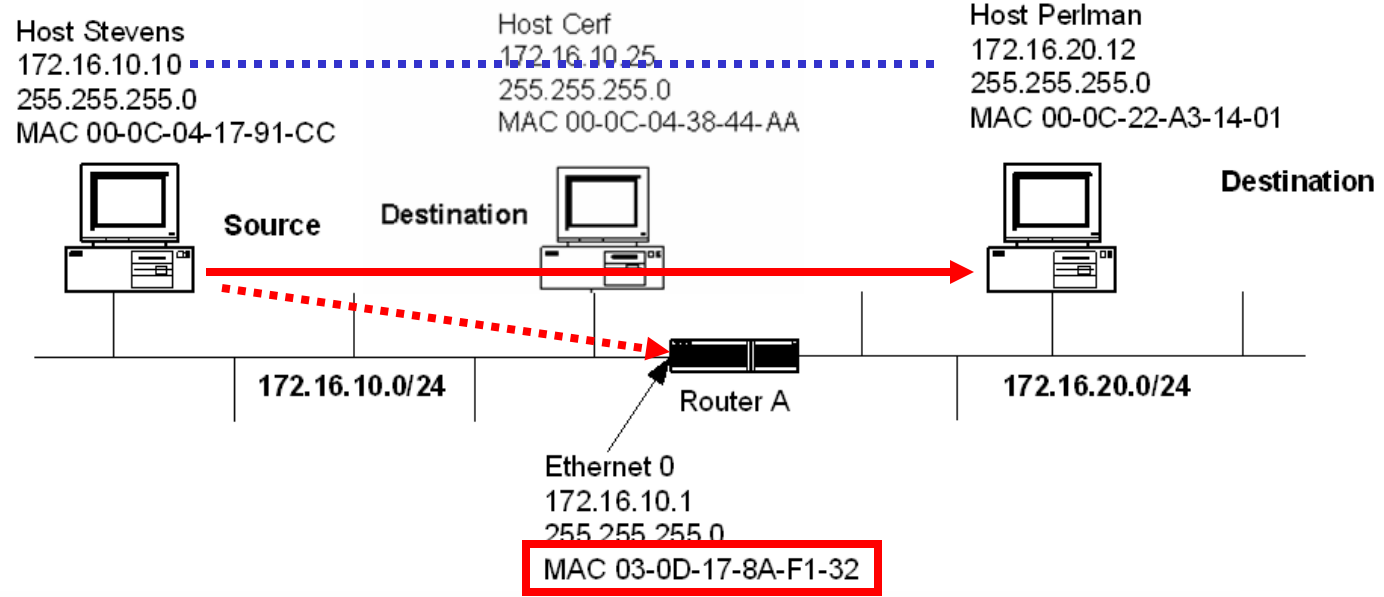
Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
00-0C-04-38-44-AA	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

Same network

- What would the Destination MAC address be for IP packets sent within the **same LAN, network**?
 - The Destination MAC address would be that of the device that we are sending the IP packet to.
 - The device's **Destination MAC address** would be associated with the **Destination IP address**.

Destination MAC

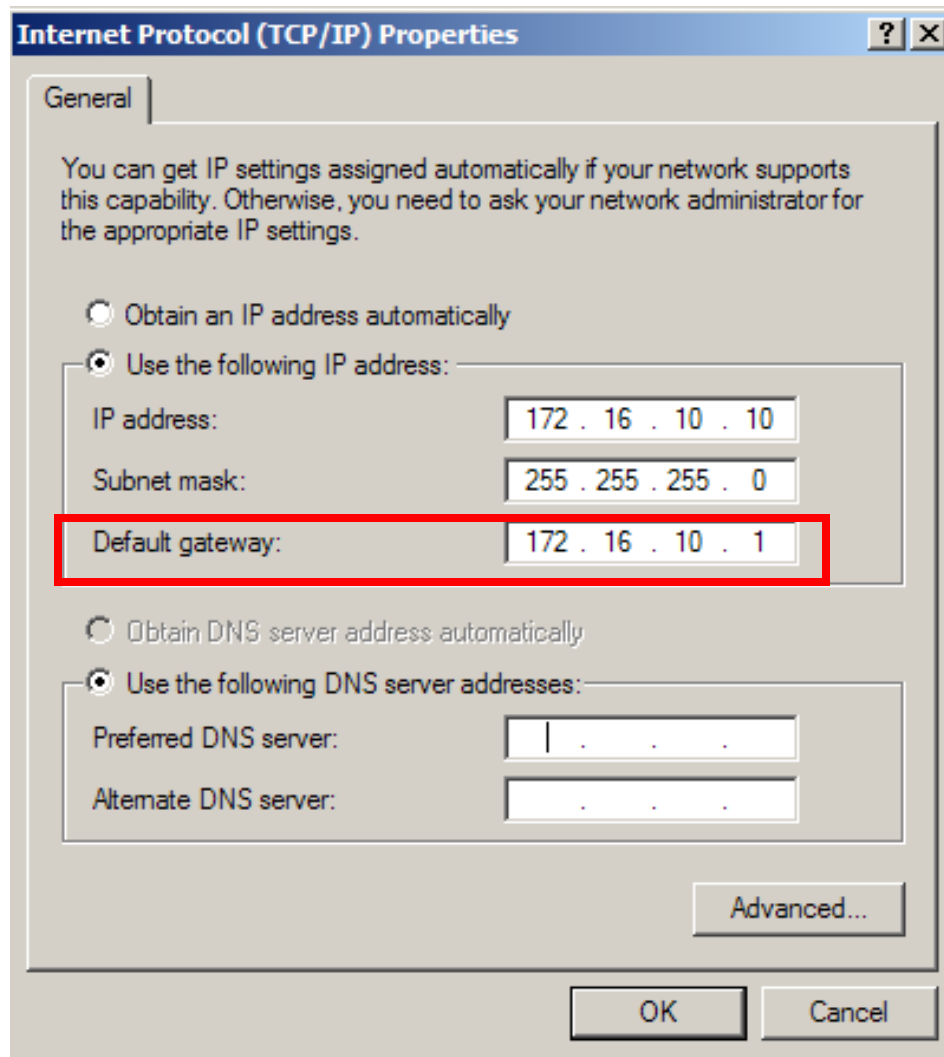
Address



Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
00-0D-17-8A-F1-32	00-0C-04-17-91-CC		172.16.10.10	172.16.20.12		

Different network

- What would the Destination MAC address for IP packets sent outside the LAN, on a **different network**?
 - The destination **MAC address** will be the MAC address associated with the **IP Address of the Default Gateway**.
 - The host must know the IP address of the Default Gateway to communicate with devices outside its own network.



**Router's IP
Address**

The Default Gateway, Router, will have an IP address and subnet mask that is on the same network as the hosts on that network.

Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			Same network?			

Same Network: Destination IP Address's MAC Address

Default gateway:

172 . 16 . 10 . 1

Different Network: The Default Gateway's MAC Address

- The Destination MAC Address will always be one of two addresses.
 - **Same network:** The MAC address associated with the device's Destination IP Address.
 - **Different network:** The MAC address associated with the IP Address of the Default Gateway.

Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data

Same network?

So, here is the **big question**:

- ***How do does the sending host know if the Source IP Address and Destination IP Address are on the same network?***

Hints:

- How does a host know what network it is on?
- What do all devices in the same network have in common?

Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data

Same network?

So, here is the **big question**:

- ***How do does the sending host know if the Source IP Address and Destination IP Address are on the same network?***

Hints:

- How does a host know what network it is on?
 - Does an AND operation on its host IP address and subnet mask.
- What do all devices in the same network have in common?
 - They all have the same subnet mask (and of course a host IP address in the same network).

Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10			

Same network?

- How does a host know what network it is on?
 - Does an AND operation on its host IP address and subnet mask.
- We know how a host can tell what network it belongs to.

IP address:	AND	172 . 16 . 10 . 10
Subnet mask:		255 . 255 . 255 . 0

My Network = 172.16.10.0

Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10	172.16.10.25		

Same network?

- What do all devices in the same network have in common?
 - They all have the same subnet mask (and of course a host IP address in the same network).
- If the Destination host is on the same network as the Source host, that would mean there Subnet Masks would be the same.
- Do an AND operation on the Destination IP Address and the Subnet Mask of the sending host.

IP address: **172.16.10.25**

Subnet mask: **255 . 255 . 255 . 0**

AND

Destination Network = 172.16.10.0

- If this matches the sending host's network, then they are on the same network.
- If it does not match the sending host's network, then they are on different networks.

Destination MAC Address?

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Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10	172.16.10.25		

Same network?

IP address: **AND** 172 . 16 . 10 . 10
Subnet mask: 255 . 255 . 255 . 0

IP address: **AND** 172.16.10.25
Subnet mask: 255 . 255 . 255 . 0

My Network = 172.16.10.0

Destination Network = 172.16.10.0

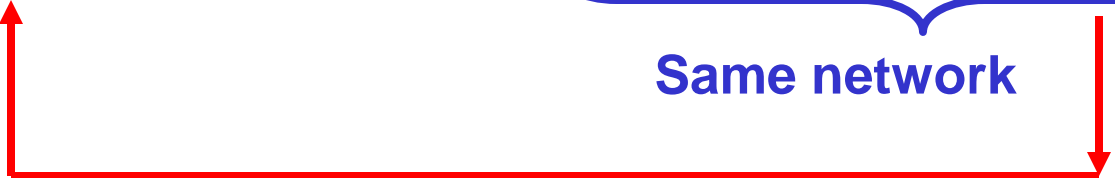
Same network? YES!

- In this case both the Source IP Address and the Destination IP Address are on the same network.

Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
?			172.16.10.10	172.16.10.25		

Same network



Same Network: Destination IP Address's MAC Address

- Since they are on the same network, the Destination MAC Address will be the MAC Address of the host with the Destination IP Address.
- Where does the sending host look for this information?

ARP: Address Resolution Protocol

The ARP Table or ARP Cache

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IP Address to MAC Address Mappings

ARP Table

<u>IP Address</u>	<u>MAC Address</u>
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Host Stevens

172.16.10.10

255.255.255.0

MAC 00-0C-04-17-91-CC

Source



The TCP/IP Suite of Protocols

Application	File Transfer: FTP, TFTP, NFS, HTTP Email: SMTP Remote Login: Telnet, rlogin Network Management: SNMP, BootP Name Management: DNS, DHCP
Transport	TCP, UDP
Internet/Network	IP, ICMP, IGMP, ARP, RARP
Network Interface (Link Layer)	Not Specified: Ethernet, 802.3, Token Ring, 802.5, FDDI, ATM,

Ethernet Header		IP Header				
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
00-0C-04-38-44-AA	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

It will look for it in it's **ARP Table** or **ARP Cache**.

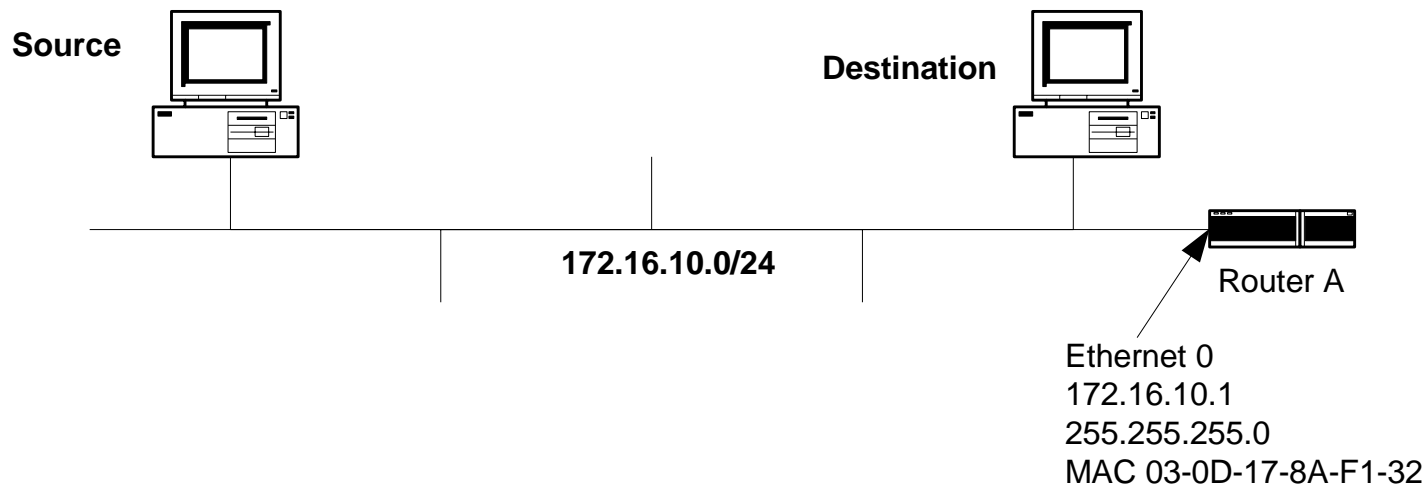
- The ARP Table maintains IP Address to MAC Address mappings.
- Every device that participates in Ethernet and IP will have such a table, including hosts and routers.

Destination MAC Address???

ARP Table	
IP Address	MAC Address
172.16.10.25	00-0C-04-38-44-AA

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Cerf
172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA



Ethernet Header		IP Header				
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

Same network

Destination MAC Address???

No Match

ARP Table

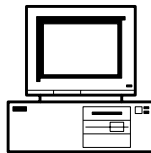
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

- What if the Destination IP Address is not in the ARP Table?
- How does it get in there?
- The host must issue an **ARP Request**.

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Cerf
172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA

Source



Destination



172.16.10.0/24

Router A

Ethernet 0
172.16.10.1
255.255.255.0
MAC 03-0D-17-8A-F1-32

ARP: A quick look

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Destination MAC Address???

ARP Table

IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

172.16.10.25 00-0C-04-38-44-AA

HOST STEVENS

ARP Request: Who has IP Address 172.16.10.25? Please send me your MAC Address.

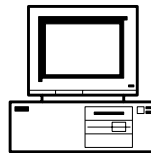
L2 Broadcast to all devices on network

Host Conf

172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA

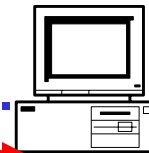
ARP Reply: Here is my MAC Address

Source



L2 Unicast only to sender of ARP Request

Destination



IP Packet now sent to Destination

172.16.10.0/24

Router A

Ethernet 0
172.16.10.1
255.255.255.0
MAC 03-0D-17-8A-F1-32

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
00-0C-04-38-44-AA	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

IP Packet no longer on hold

Hey that's me!

I will add that to my ARP Table.

I will now use the MAC Address to forward the frame.

What if the hosts are on different networks?

Host Stevens

172.16.10.10

255.255.255.0

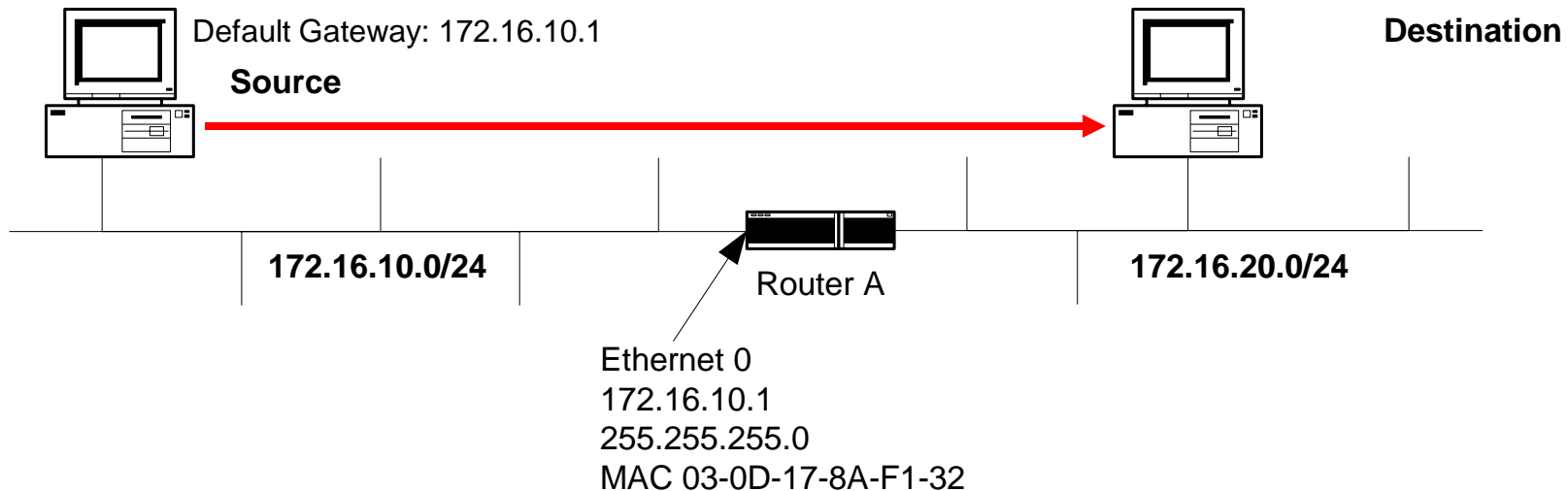
MAC 00-0C-04-17-91-CC

Host Perlman

172.16.20.12

255.255.255.0

MAC 00-0C-22-A3-14-01



Ethernet Header

IP Header

Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
?	00-0C-04-17-91-CC		172.16.10.10	172.16.20.12		

Here we have an example of Host Stevens at IP address 172.16.10.10 wanting to send an IP packet to Host Perlman at IP address 172.16.20.12

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
				?		

Same Network: Destination IP Address's MAC Address

Default gateway:

172 . 16 . 10 . 1

Different Network: The Default Gateway's MAC Address

- The Destination MAC Address will always be one of two addresses.
 - **Same network:** The MAC address associated with the device's Destination IP Address.
 - **Different network:** The MAC address associated with the IP Address of the Default Gateway.

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data

Same network?

So, here is the **big question**:

- ***How do does the sending host know if the Source IP Address and Destination IP Address are on the same network?***

Hints:

- How does a host know what network it is on?
- What do all devices in the same network have in common?

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data

Same network?

So, here is the **big question**:

- ***How do does the sending host know if the Source IP Address and Destination IP Address are on the same network?***

Hints:

- How does a host know what network it is on?
 - Does an AND operation on its host IP address and subnet mask.
- What do all devices in the same network have in common?
 - They all have the same subnet mask (and of course a host IP address in the same network).

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10			

Same network?

- How does a host know what network it is on?
 - Does an AND operation on its host IP address and subnet mask.
- We know how a host can tell what network it belongs to.

IP address:	AND	172 . 16 . 10 . 10
Subnet mask:		255 . 255 . 255 . 0

My Network = 172.16.10.0

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10	172.16.20.12		

Same network?

- What do all devices in the same network have in common?
 - They all have the same subnet mask (and of course a host IP address in the same network).
- If the Destination host is on the same network as the Source host, that would mean there Subnet Masks would be the same.
- Do an AND operation on the Destination IP Address and the Subnet Mask of the sending host.

IP address: 172.16.20.12
AND
Subnet mask: 255 . 255 . 255 . 0

Destination Network = 172.16.20.0

- If this matches the sending host's network, then they are on the same network.
- If it does not match the sending host's network, then they are on different networks.

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10	172.16.20.12		

Same network?

IP address: **AND** 172 . 16 . 10 . 10
Subnet mask: 255 . 255 . 255 . 0

My Network = 172.16.10.0

IP address: **AND** 172.16.20.12
Subnet mask: 255 . 255 . 255 . 0

Destination Network = 172.16.20.0

Same network? NO!

- In this case both the Source IP Address and the Destination IP Address are on different networks.

Review: Destination MAC Address?

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
			172.16.10.10	172.16.20.12		

Different networks

Default gateway:

172 . 16 . 10 . 1

Different Network: The Default Gateway's MAC Address

- Since they are on **different networks**, the Destination MAC Address will be the **MAC Address** of the device with the **Default Gateway IP Address**.
- The IP Address of the Default Gateway must be known by the sending host in order to communicate with devices outside its own network.
- Where does the sending host look for this information?

ARP: Address Resolution Protocol

The ARP Table or ARP Cache

IP Address to MAC Address Mappings

ARP Table

<u>IP Address</u>	<u>MAC Address</u>
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Host Stevens

172.16.10.10

255.255.255.0

MAC 00-0C-04-17-91-CC

Source



The TCP/IP Suite of Protocols

Application	File Transfer: FTP, TFTP, NFS, HTTP Email: SMTP Remote Login: Telnet, rlogin Network Management: SNMP, BootP Name Management: DNS, DHCP
Transport	TCP, UDP
Internet/Network	IP, ICMP, IGMP, ARP, RARP
Network Interface (Link Layer)	Not Specified: Ethernet, 802.3, Token Ring, 802.5, FDDI, ATM,

ARP: A quick look

Destination MAC Address???

ARP Table

IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

172.16.10.1 03-0D-17-8A-F1-32

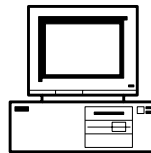
HOST STEVENS

ARP Request: Who has IP Address 172.16.10.1? Please send me your MAC Address.

L2 Broadcast to all devices on network

Host Cerf
172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA

Source



L2 Unicast only to sender of ARP Request

Destination



Hey that's me!

ARP Reply: Here is my MAC Address

Router A

Ethernet 0

172.16.10.1
255.255.255.0
MAC 03-0D-17-8A-F1-32

172.16.10.0/24

IP Packet now sent to Destination

IP Packet no longer on hold

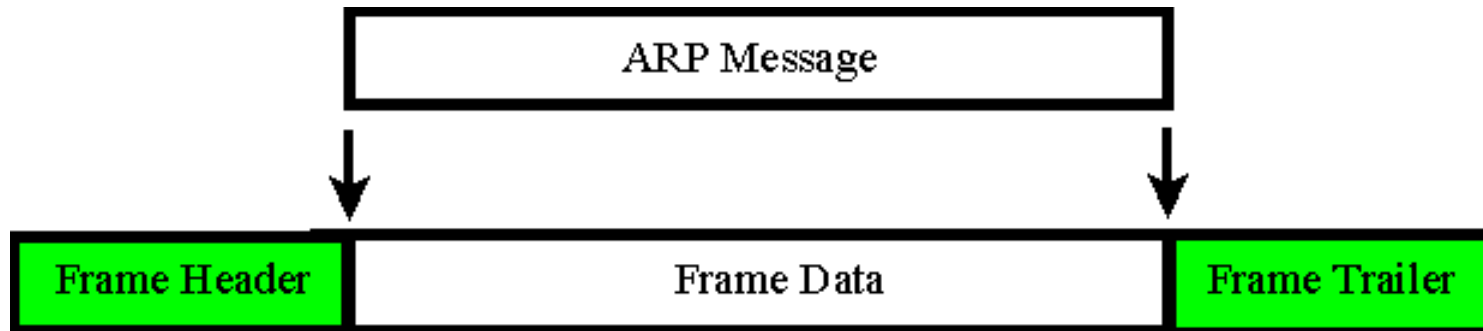
Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
03-0D-17-8A-F1-32	00-0C-04-17-91-CC		172.16.10.10	172.16.20.12		

Same network

ARP (Address Resolution Protocol)

So, what does an ARP packet look like?

Ethernet Header			Ethernet Data – 28 byte ARP request/reply				
Ethernet Destination Address (MAC)	Ethernet Source Address (MAC)	Frame Type 0x806	ARP headers , i.e. op field	Sender's Ethernet Address (MAC)	Sender's IP Address	Target's Ethernet Address (MAC)	Target's IP Address



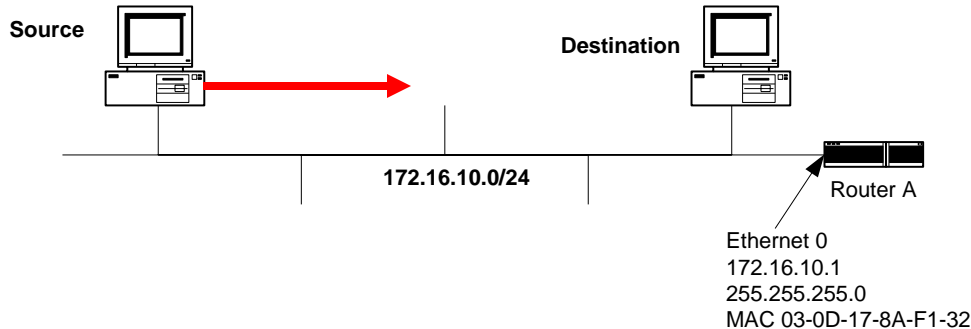
ARP Request: Same Network

Destination MAC Address???

ARP Table	
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Cerf
172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA



ARP Request from Host Stevens at 172.16.10.10, looking for the MAC address of the 172.16.10.25 (Destination IP Address).

“Hey everyone! I have this IP Address and I need the host this belongs to, to send me their MAC address.”

ARP Request from 172.16.10.10

Ethernet Header			Ethernet Data – 28 byte ARP request/reply				
Ethernet Destination Address (MAC)	Ethernet Source Address (MAC)	Frame Type	ARP headers , i.e. op field	Sender's Ethernet Address (MAC)	Sender's IP Address	Target's Ethernet Address (MAC)	Target's IP Address
FF-FF-FF-FF-FF-FF	00-0C-04-17-91-CC	0x806	op = 1	00-0C-04-17-91-CC	172.16.10.10	?	172.16.10.25

op field – ARP request = 1
ARP reply = 2
RARP request = 3
RARP reply = 4

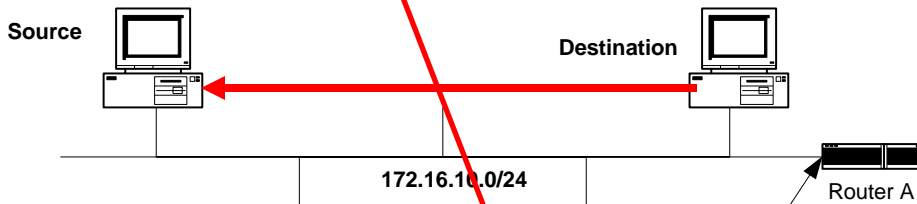
Destination MAC Address???



ARP Table	
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Cerf
172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA



**ARP Reply from
172.16.10.25, back to the
requester 172.16.10.10.**

“Hey sender of ARP Request!
Here is my MAC address that
you wanted for that IP
address.”

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
00-0C-04-38-44-AA	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

ARP Reply from 172.16.10.25

Ethernet Header			Ethernet Data – 28 byte ARP request/reply				
Ethernet Destination Address (MAC)	Ethernet Source Address (MAC)	Frame Type	ARP headers , i.e. op field	Sender's Ethernet Address (MAC)	Sender's IP Address	Target's Ethernet Address (MAC)	Target's IP Address
00-0C-04-17-91-CC	00-0C-04-38-44-AA	0x806	op = 2	00-0C-04-38-44-AA	172.16.10.25	00-0C-04-17-91-CC	172.16.10.10

Here it is!

Destination MAC Address???

ARP Table

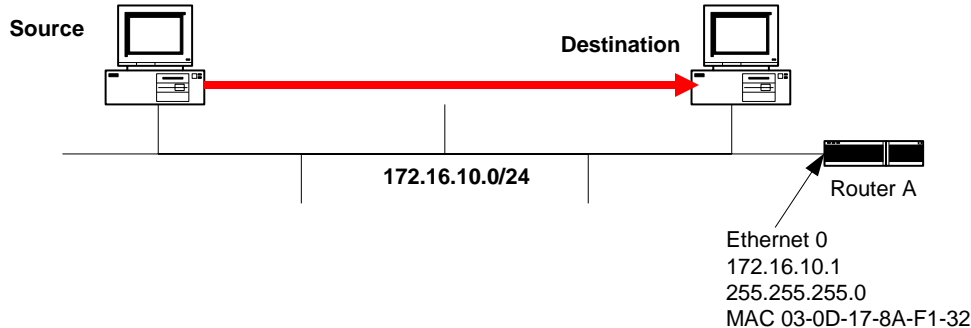
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Added to ARP Table

172.16.10.25 00-0C-04-38-44-AA

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Cerf
172.16.10.25
255.255.255.0
MAC 00-0C-04-38-44-AA



- Host Stevens receives the ARP Reply and enters Host Cerf's IP address and MAC address into its ARP Table.
- Host Stevens now has all it needs to encapsulate the IP packet into the Ethernet frame and send that packet directly to Host Cerf.

Ethernet Header

IP Header

Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
00-0C-04-38-44-AA	00-0C-04-17-91-CC		172.16.10.10	172.16.10.25		

ARP Request: Different Networks (Default Gateway)

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Default Gateway's (the router's)
MAC Address???

ARP Table	
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

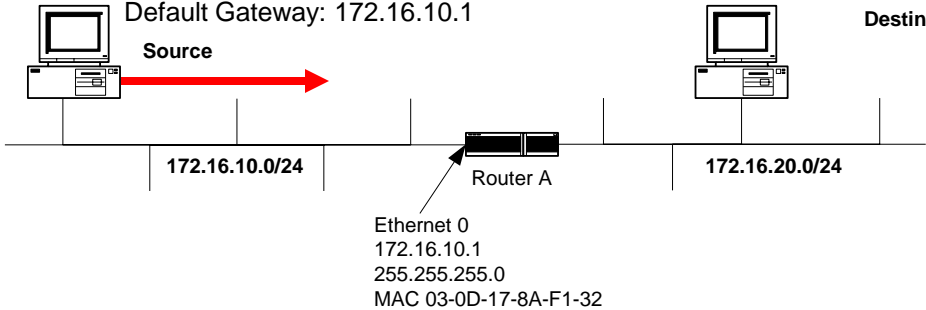
Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Default Gateway: 172.16.10.1

Source

Host Perlman
172.16.20.12
255.255.255.0
MAC 00-0C-22-A3-14-01

Destination



ARP Request from 172.16.10.10 looking for MAC of 172.16.10.1 (Default Gateway)

“Hey everyone! I have this IP Address, 172.16.10.1, and I need the device this belongs to, to send me their MAC address.”

ARP Request from 172.16.10.10

Ethernet Header			Ethernet Data – 28 byte ARP request/reply				
Ethernet Destination Address (MAC)	Ethernet Source Address (MAC)	Frame Type	ARP headers , i.e. op field	Sender's Ethernet Address (MAC)	Sender's IP Address	Target's Ethernet Address (MAC)	Target's IP Address
FF-FF-FF-FF-FF-FF	00-0C-04-17-91-CC	0x806	op = 1	00-0C-04-17-91-CC	172.16.10.10	?	172.16.10.1

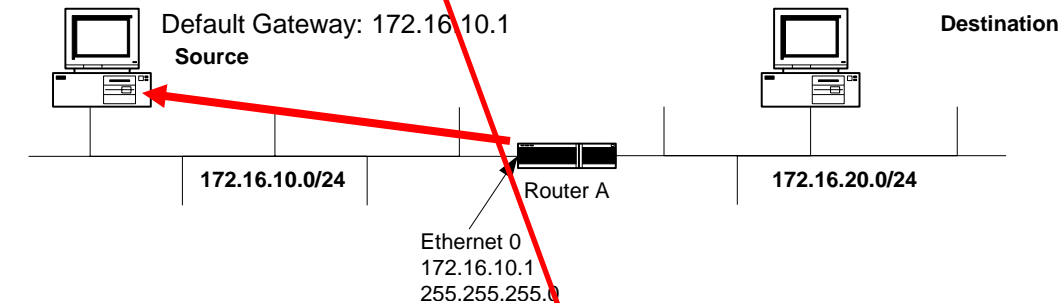
op field – ARP request = 1
ARP reply = 2
RARP request = 3
RARP reply = 4

Default Gateway's (the router's)
MAC Address???

ARP Table	
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Perlman
172.16.20.12
255.255.255.0
MAC 00-0C-22-A3-14-01



ARP Reply from Router A at 172.16.10.1, back to the sender, Host Stevens

“Hey sender of ARP Request! Here is my MAC address that you wanted for that IP address.”

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
03-0D-17-8A-F1-32	00-0C-04-17-91-CC		172.16.10.10	172.16.20.12		

ARP Reply from 172.16.10.1

Ethernet Header			Ethernet Data – 28 byte ARP request/reply				
Ethernet Destination Address (MAC)	Ethernet Source Address (MAC)	Frame Type	ARP headers, i.e. op field	Sender's Ethernet Address (MAC)	Sender's IP Address	Target's Ethernet Address (MAC)	Target's IP Address
00-0C-04-17-91-CC	03-0D-17-8A-F1-32	0x806	op = 2	03-0D-17-8A-F1-32	172.16.10.1	00-0C-04-17-91-CC	172.16.10.10

Here it is!

Default Gateway's (the router's)
MAC Address???

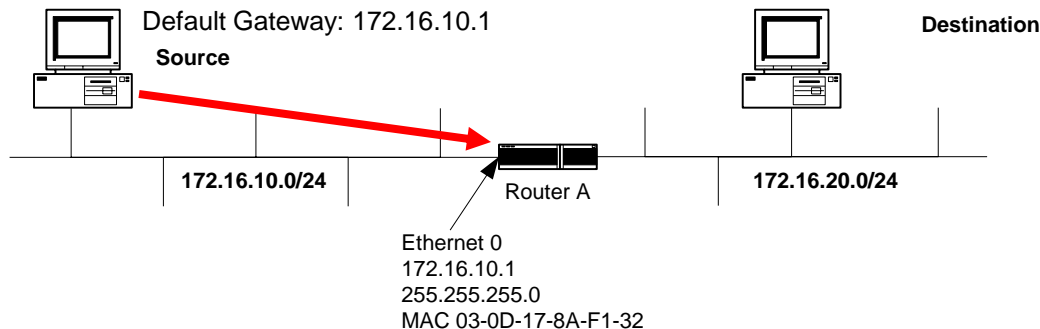
ARP Table	
IP Address	MAC Address
172.16.10.3	00-0C-04-32-14-A1
172.16.10.19	00-0C-14-02-00-19
172.16.10.33	00-0C-A6-19-46-C1

Added to ARP Table

172.16.10.1 03-0D-17-8A-F1-32

Host Stevens
172.16.10.10
255.255.255.0
MAC 00-0C-04-17-91-CC

Host Perlman
172.16.20.12
255.255.255.0
MAC 00-0C-22-A3-14-01



- Host Stevens receives the ARP Reply and enters Router A's IP address and MAC address into its ARP Table.
- Host Stevens now has all it needs to encapsulate the IP packet into the Ethernet frame and send that packet to Router A.
- It is now up to Router A to forward the packet onward.

Ethernet Header

IP Header

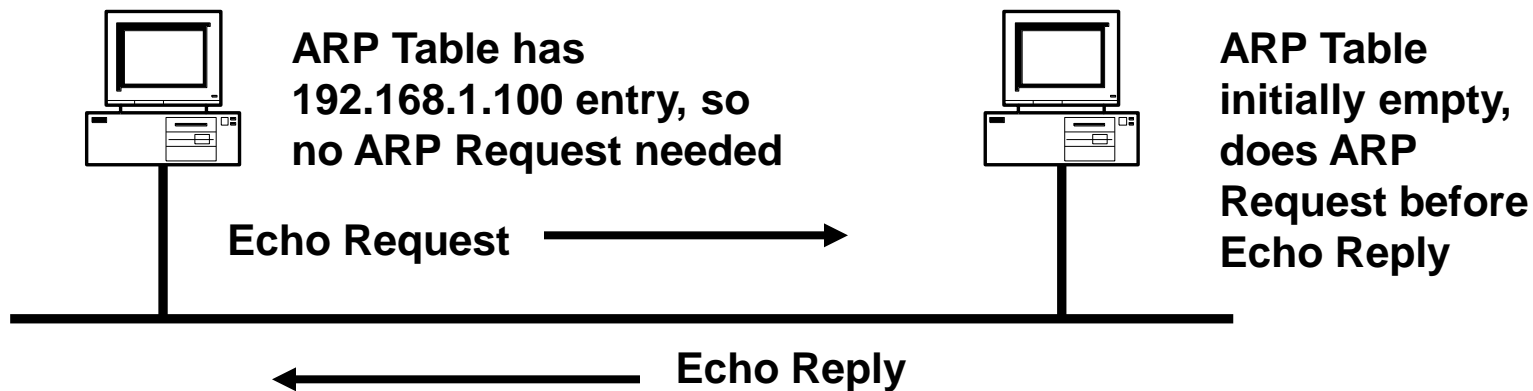
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
03-0D-17-8A-F1-32	00-0C-04-17-91-CC		172.16.10.10	172.16.20.12		

Does the receiver of the ARP Request need to do its own ARP Request?

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192.168.1.10/24

192.168.1.100/24

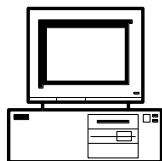


		<u>Destination IP</u>	<u>Source IP</u>		
000001	102	192.168.1.100	192.168.1.10	ICMP	Echo Request
000002	64	BROADCAST	192.168.1.100	ARP	Q PA=192.168.1.10
000003	64	192.168.1.100	192.168.1.10	ARP	R HA=00A0C98D8C03
000004	102	192.168.1.10	192.168.1.100	ICMP	Echo Reply
000005	102	192.168.1.100	192.168.1.10	ICMP	Echo Request
000006	102	192.168.1.10	192.168.1.100	ICMP	Echo Reply
000007	102	192.168.1.100	192.168.1.10	ICMP	Echo Request
000008	102	192.168.1.10	192.168.1.100	ICMP	Echo Reply
000009	102	192.168.1.100	192.168.1.10	ICMP	Echo Request
000010	102	192.168.1.10	192.168.1.100	ICMP	Echo Reply

Does the receiver of the ARP Request need to do its own ARP Request?

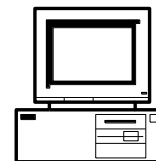
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192.168.1.10/24



ARP Table initially empty,
so will first need to do an
ARP Request

192.168.1.100/24



ARP Table
initially empty,
adds sender's
IP address to
ARP Table
before doing
ARP Reply

Echo Request



Echo Reply

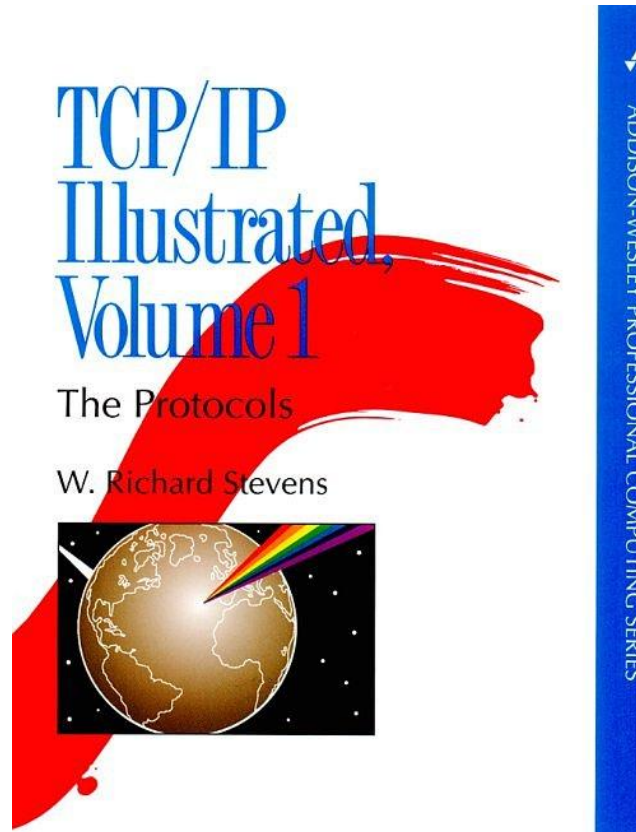


		<u>Destination IP</u>	<u>Source IP</u>	
000001	102	192.168.1.100	192.168.1.10	ICMP Echo Request
000002	64	BROADCAST	192.168.1.100	ARP Q PA=192.168.1.10
000003	64	192.168.1.100	192.168.1.10	ARP R HA=00A0C98D8C03
000004	102	192.168.1.10	192.168.1.100	ICMP Echo Reply
000005	102	192.168.1.100	192.168.1.10	ICMP Echo Request
000006	102	192.168.1.10	192.168.1.100	ICMP Echo Reply
000007	102	192.168.1.100	192.168.1.10	ICMP Echo Request
000008	102	192.168.1.10	192.168.1.100	ICMP Echo Reply
000009	102	192.168.1.100	192.168.1.10	ICMP Echo Request
000010	102	192.168.1.10	192.168.1.100	ICMP Echo Reply

This is dependent on the operating system. With most host operating systems, the receiver (target) of the ARP Request will add the IP address of the sender of this ARP Request to its ARP Table. However, some devices will not do record the sender of the ARP Request's IP and MAC address and will need to do an ARP Request of its own.

For more information...

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Suggested Reading: **The Protocols (TCP/IP Illustrated, Volume 1)** by
W. Richard Stevens, ISBN: 0201633469

ARP

The Process and the Protocol



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CIS 81 and CST 311

Rick Graziani

Fall 2006